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ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH (ENGLAND)  
THE MODIFICATION OF A PENLESS THERMAL CHART RECORDER TO DIRECTL--ETC(U)  
JAN 82 J A BEATTIE  
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THE MODIFICATION OF A PENLESS THERMAL CHART RECORDER  
TO DIRECTLY DISPLAY DIGITAL TELEMETRY DATA

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J. A. C. Beattie

January 1982

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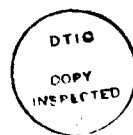
THE MODIFICATION OF A PENLESS THERMAL CHART RECORDER  
TO DIRECTLY DISPLAY DIGITAL TELEMETRY DATA

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J. A. C. Beattie

SUMMARY

A microprocessor based thermal chart recorder, has been modified to accept serial digital telemetry, and to output a synchronous display of up to six selected data bytes.



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## 1 INTRODUCTION

Presentation of telemetered data from unmanned aircraft trials is currently made on a multipen strip chart recorder. The data from the digital telemetry signal is decommutated, converted to an analogue signal and held at the given voltage between readings.

There are a number of drawbacks to the system. Firstly the digital data has to be converted to analogue; secondly the recorder has to be loaded and unloaded with pens; thirdly the pens are offset along the time axis to allow room for the drive mechanism to each pen; finally the data is presented as a smooth analogue curve, when strictly this does not reflect the true character of the information contained in a time multiplexed serial digital data stream.

It was thought that these drawbacks could be overcome and further facilities gained, if full advantage was made of a commercially available, microprocessor controlled, thermal strip chart printer.

The conversion work was carried out by Data Associates Ltd of Woodley, Reading.

## 2 BASIC RECORDER

The recorder used was a Smiths Industries Ltd Venture 700 recorder. This is a penless strip chart recorder accommodating 10 inch wide thermal paper in 25 metre rolls housed at the rear of the instrument.

The writing head is made up of 256 thermal printing dots mounted on four ceramic substrates, in turn mounted on a carrying bar with alignment and pressure controls, the dots write a 1mm wide line and are spaced 1 mm apart. A typical record is shown in Fig 1.

The front panel controls are by touch panel and the paper advance, speed and direction are available to the operator.

The whole system is controlled by an Intersil 8085 microprocessor. The software is stored in an EPROM of type 2716.

## 3 FORMAT OF TELEMETRY DATA

The RAE lightweight telemetry encoder Mk II as currently used for all RAE and RAE contracted unmanned aircraft, produces a serial digital data frame of the following format.

The frame consists of 32 bytes, the first two of which are synchronizing code. The remaining 30 are divided into 24 analogue sourced channels and six digital status or flag sourced bytes. The analogue bytes are to be treated as unsigned scalar quantities with a maximum value of 255.

The data rate is 4096 Hz giving 16 samples per second (this can be raised up to 8192 Hz by substitution of a PCB in the encoder but this recorder can only cope with 4096 Hz).

The data for the Venture 700 recorder is taken from the receiver after bit conditioning, as a continuous bit stream of 5 volt magnitude from CMOS outputs coded NRZ with MSB transmitted first.

Two parallel lines having frame start and byte start pulses are also provided. The frame pulse is 40  $\mu$ s long and starts half way through the first bit of the first byte following synchronization. The channel pulse is 1  $\mu$ s long and starts half way through the first bit of every byte.

#### 4 RECORDER AND MODIFICATION SPECIFICATION

##### 4.1 Specification

###### 4.1.2 Data input

Serial digital telemetry data as described in section 3 above. Input to be via five-pin 180° DIN plug (Ref RS477876). Pinning is shown in Table 1.

###### 4.1.2 Data selection

Six thumbwheel switches are to be provided to allow selection of the required data channel. The channels will be numbered 0 to 31 where channels 0 and 1 are the two synchronization bytes.

Selection of channel zero will indicate that an output channel is to be selected but no data or print instructions are to be provided.

Selection of two identical channels, a non existent channel or less than two channels will cause an error lamp to be illuminated.

###### 4.1.3 Data output

Data output is initiated by pressing a 'RUN' button. The selected channels will have the number printed in the centre of each recording space and then recording will start.

The paper speed will be selected by the Venture 700 touch panel and be independent of data input.

The channel gain and spacing will be automatic and dependent on the number of channels chosen. Gains and resolution are shown in Table 2. The output of the three options available are shown in Figs 1, 2 and 3.

###### 4.1.4 Conditions

(i) Spare input pin to be available for operation of marker dot on right-hand side of chart.

(ii) On loss of data or corruption of data in a recording run, the paper should continue to advance, printing should be suspended and the marker dot activated. On reception of good data, the marker dot should be extinguished and printing of data recommenced.

(iii) On loss of paper, or manual paper control printing will be adjusted to suit, including suspension of printing on a paper stop command.

(iv) If the digiswitches selecting channel are altered during a run, they will have no effect until the initializing run button is pressed.

(v) Short format telemetry

If short format telemetry, that is 16 byte frame, is presented to the recorder a maximum of four channels only is allowed to be selected. There is insufficient time to print more channels between frame pulses. The remaining two channels, in case of the maximum four being selected, will show '0' heading and no trace.

5 OPERATION

- (i) Switch on.
- (ii) Connect the telemetry cable terminated in a DIN plug to the rear of the instrument and the cannon 'D' plug termination to the output of the bit conditioner.
- (iii) Select the required channels - note select '00' for unwanted channels and a minimum of two data channels.
- (iv) Select paper speed.
- (v) Press RUN button.
- (vi) Select paper advance forward.
- (vii) Lock touch switches.

6 INTERPRETATION OF OUTPUT

The data is a byte, truncated as necessary (see Table 2), and displayed on the paper as a 1mm wide thermally produced dot a given distance from the left-hand edge of the channel space. Its time relationship with the adjacent channels and any subsequent dots of the channel in question, is shown by the longitudinal spacing on the paper, which in turn is modified by the speed of paper advance.

The chart is only available divided along the paper in 1 cm divisions, and across the paper in per cent of full scale from the left-hand edge. To aid in interpretation away from the run headings, a perspex overlay has been made (Fig 4) that is justified to the left-hand edge and shows maximum, minimum and centre of each channel.

7 CONCLUSION

A penless thermal chart recorder has been successfully modified to accept direct serial digital telemetry data, and is available for use by experimenters in TDCO, RAE Farnborough.

Table 1

PLUG TYPE  
FIVE-PIN 180° DIN STANDARD

Pin	Function
1	Frame pulse
2	Byte pulse
3	Ground
4	Data bit stream
5	Spare

Table 2

No. of channels selected	No. of channels displayed	Resolution dots per channel	Spacing, dots. Edge to edge of channels	Gain factor bits used
1		None allowed condition		
2	2	128	128	±2.0
3	3	64	83	±4.0
4	6	40	42	±6.4
5	6	40	42	±6.4
6	6	40	42	±6.4

Table 3

RECORDER DETAILS

Chart speed	Units
1.5, 3.0, 5.0, 6.0, 10.0, 15.0, 30.0, 60.0	cm/hour
1.5, 3.0, 5.0, 6.0, 10.0, 15.0, 30.0, 60.0	cm/min

Paper : length - 25 metre (roll)  
width - 280 mm  
perforations - both edges  
type - thermally sensitive



Fig 1

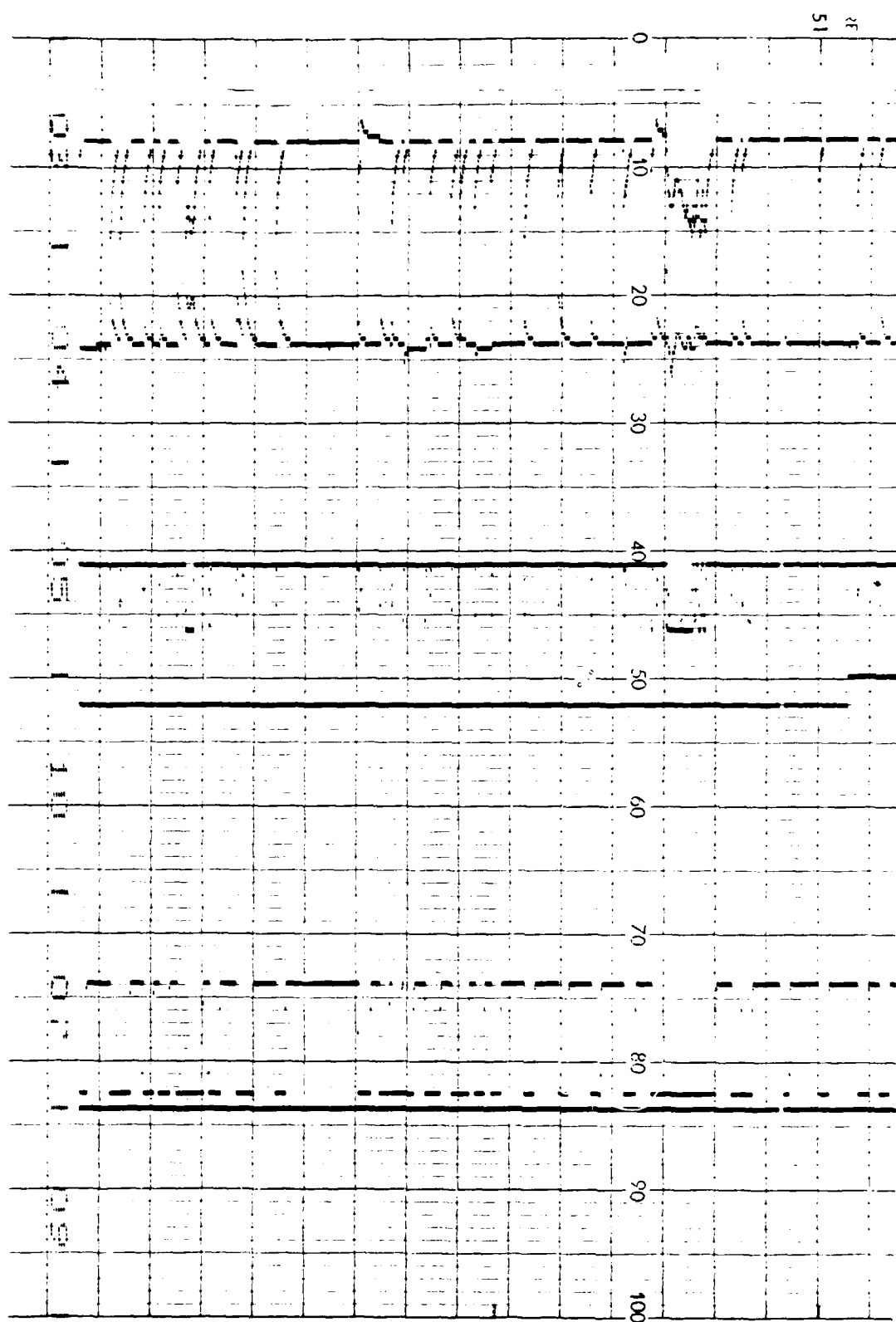


Fig 1 Six channels

Fig 2

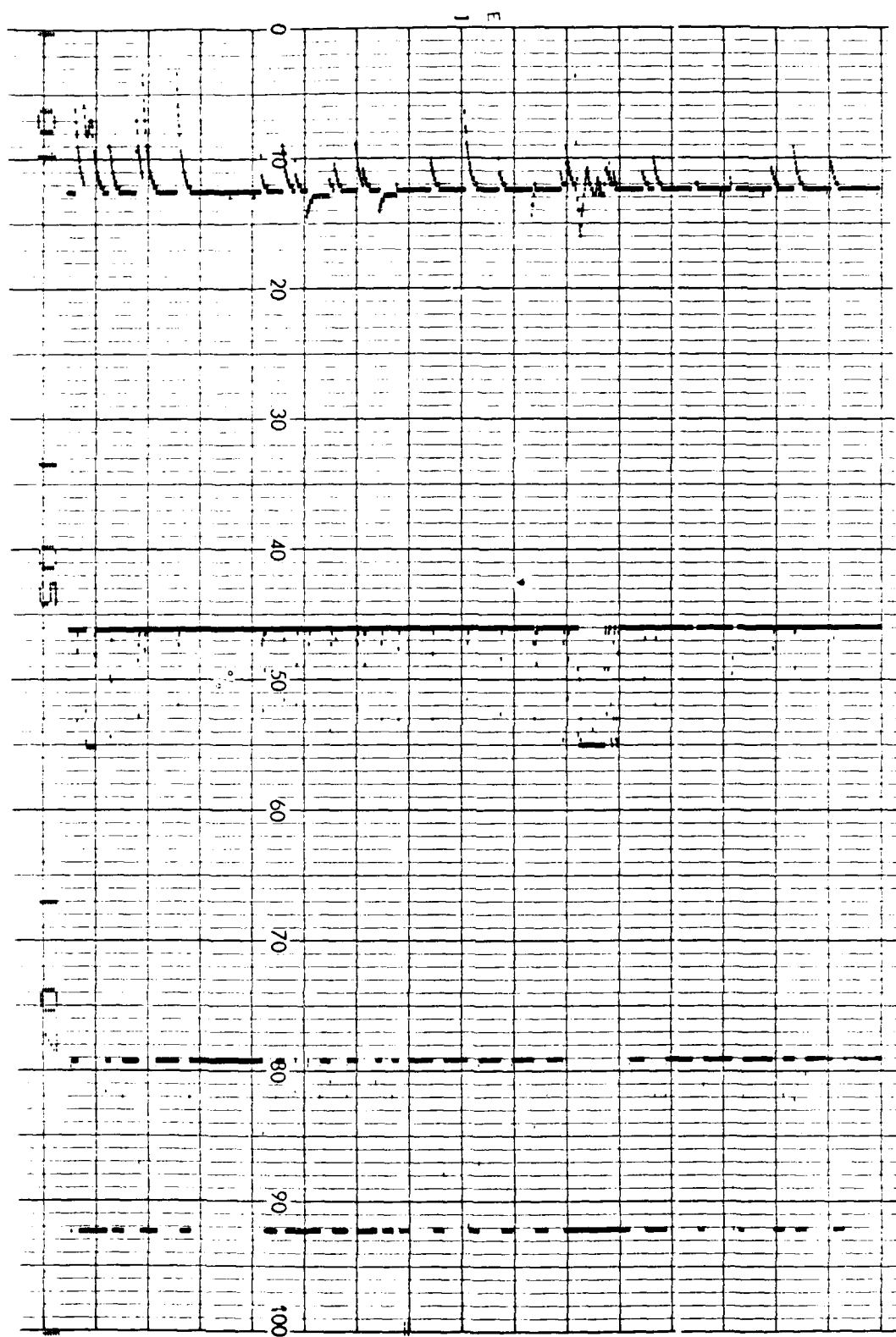


Fig 2 Three channels

Fig 3

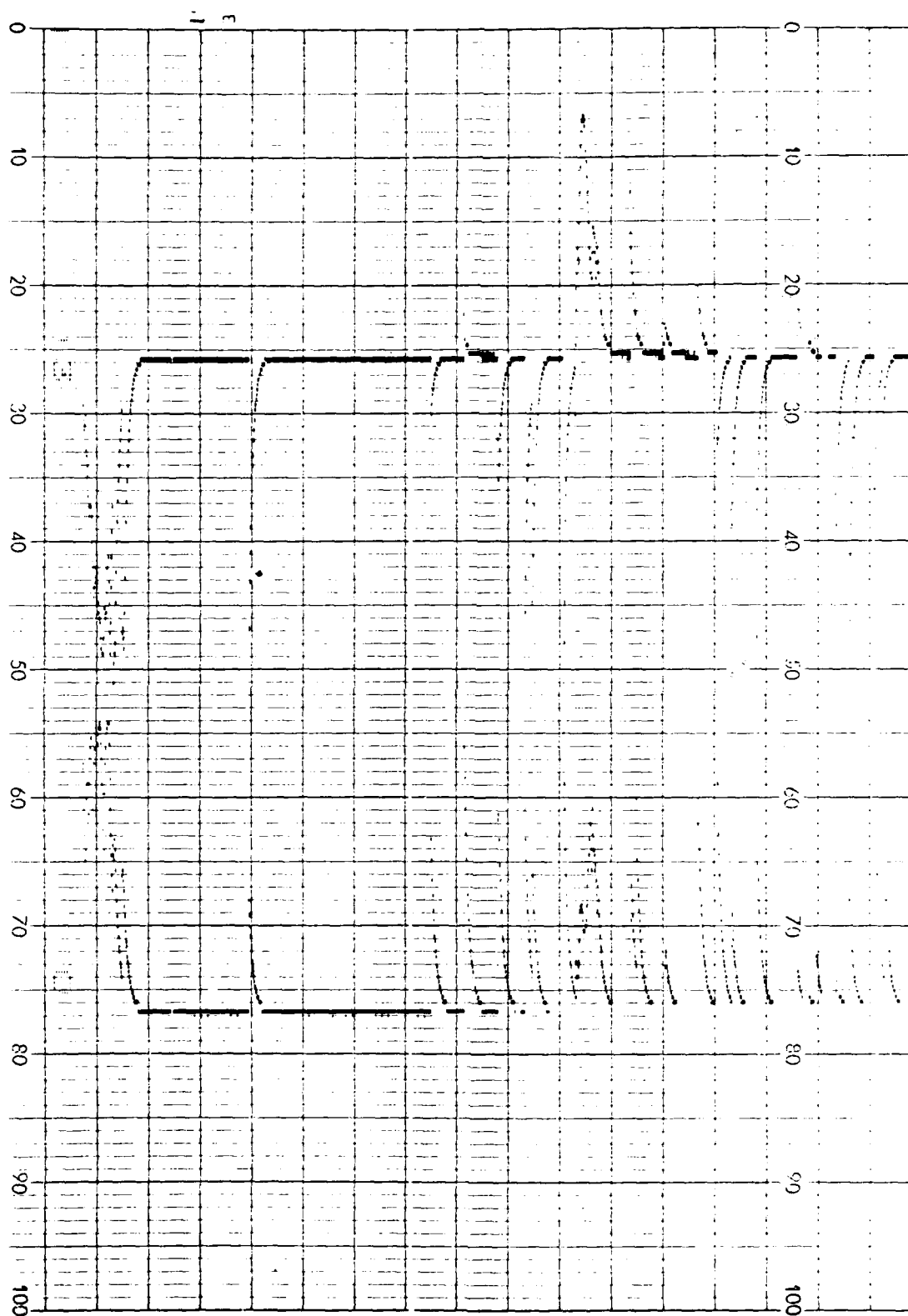


Fig 3 Two channels

Fig 4

# VENTURE 700 DIGITAL TELEMETRY RECORDER

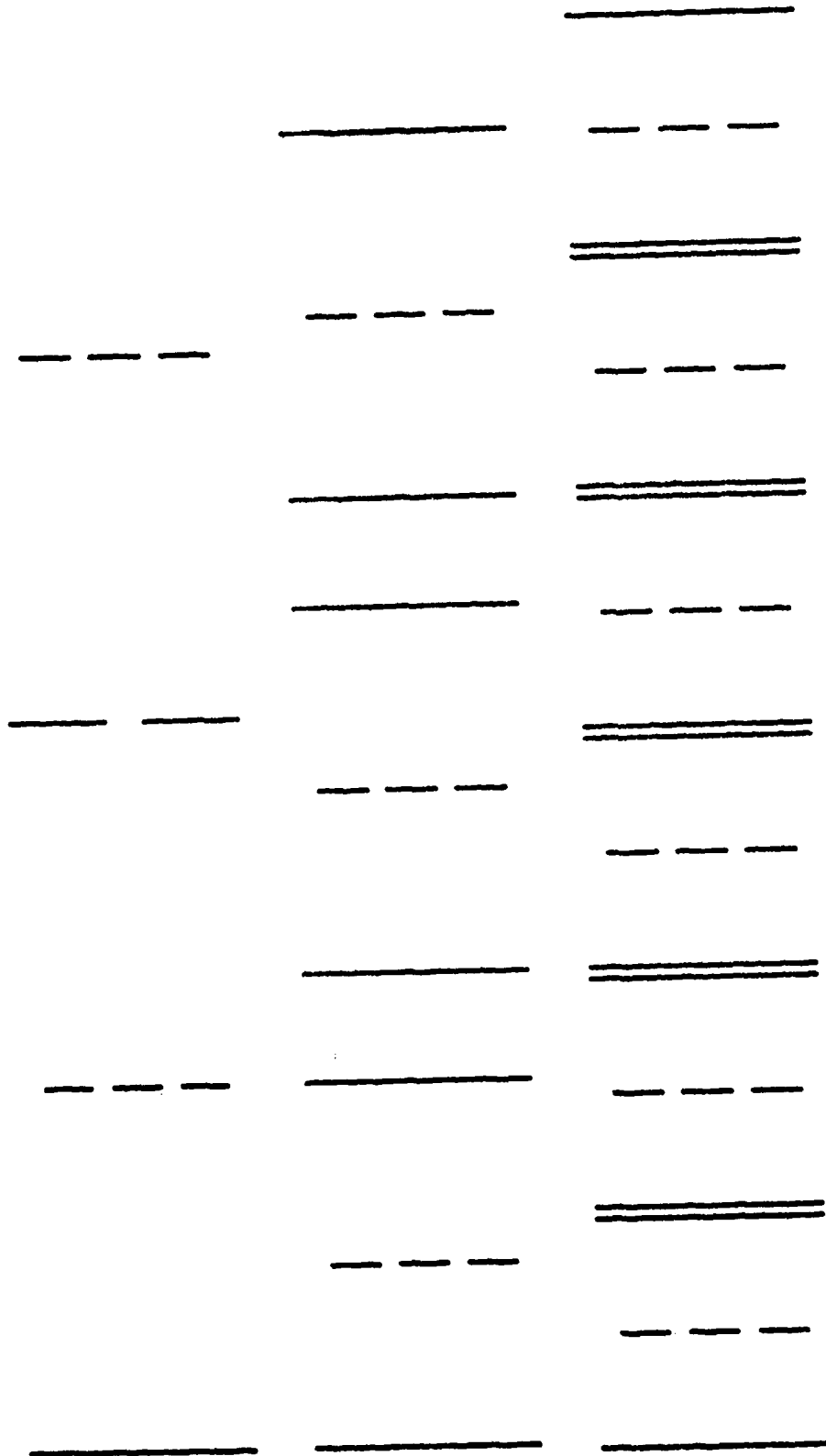


Fig 4 Xerox copy of pers

# REPORT DOCUMENTATION PAGE

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